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(54) FILTERING ELEMENT

(71) We, CENTRE D'ETUDES ET DE RECHERCHES DES ETATS DE SURFACE, a Company organised and existing under the laws of the Republic of France, residing at 71, Boulevard Edouard Branly 93—Romainville (France), do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a filtering element of the type suitable for use with fluids at high pressures.

It is an object of the invention to provide a filtering element of the above type which responds better to various desiderata of practice better than those available hitherto.

The filtering element according to the invention comprises a peripheral metallic support surrounding an assembly of uniformly arranged crossed metallic wires with the wires contacting the support at their extremities, at least some of the wires having a uniform metallic coating of silver, copper, gold or nickel, or of an alloy having as a major constituent one of these metals, the coating being from 1μ to 50μ thick, the said coated wires being bonded both to one another and, where they contact the peripheral support, to the support by means of the metallic coating being fused to the points of contact respectively of the crossing wires and of the wires with the support.

It is a further object of the invention to provide a method of manufacturing the abovesaid filtering element, wherein an assembly of crossing wires at least some of which are provided with a uniform metallic coating of silver, copper, gold or nickel or of an alloy having as a major constituent one of these metals is arranged within a peripheral metallic support such that at least some of the wires contact the support at their extremities, and then the assembly and support are heated such that the metallic coating on at least some of the wires fuse to join the wires together at their points of contact, and to join the wires to the support.

Certain preferred features of the invention will become apparent from the following description of examples of filtering elements constructed in accordance with the invention.

The invention will now be described in greater detail, referring to the accompanying drawings, this additional description and drawings relating to preferred embodiments of the invention, given of course purely by way of illustration.

In the drawings:

Figure 1 shows diagrammatically, on a large scale, a constituent part of one embodiment of a filtering element according to the invention;

Figure 2 is a diagrammatic plan view, on the same scale as Figure 1, of a constituent part of a filtering element according to the invention and arranged according to a first modification;

Figure 3 is a diagrammatic section, on the same scale, showing certain details of a filtering element according to the invention;

Figures 4 to 7 show, in diagrammatic section, constituent portions of a filtering element according to the invention; and

Figure 8, lastly, shows in diagrammatic section a portion of a filtering element according to the invention, as well as the means necessary for its positioning in a pipe.

A filtering element of this invention comprises an assembly of crossed metallic wires 1, (Figures 1 to 3) of any cross-sectional shape. The assembly of these wires is uniformly arranged; they may possibly be woven, if necessary.

When the wires are uniformly arranged, it is possible to provide a filtering element, the pores of which are regular and of well-defined shape. The use of non-woven crossed and uniformly arranged wires enables much smaller pore dimensions to be obtained than those possible with metal gauzes in the state of the art hitherto.

If d denotes the smallest transverse dimen-

[*Price 33p*]

sion of the constituent wires of the assembly, the minimum thickness of the assembly is equal to or greater than 2d.

At least certain of the wires 1 have a coating 2 of a metal the melting point of which is less than that of the constituent metal of the wires; this metal is one of silver, copper, gold and nickel, or an alloy the major constituent of which is one of these metals.

The wires 1 of the assembly are bonded to one another by being fused together at least at certain of their points of contact. In Figure 3, there is shown at 3 one of the bonds obtained by the fusing.

When the assembly of wires 1 is in the form of a simple metallic gauze T, as shown in Figure 2, the thickness e of the coating 2 may be selected dependent on the gauze dimensions so as to give the pores 4 the required dimensions, so long as the coating thickness always falls within the limits indicated below.

The pores defined by the coating are preferably of regular shape, and when the coatings are applied to a fabricated gauze, the pores should be of the same shape as the initial pores of the gauze without including any excrescences or metallic accumulations capable of impeding the flow of a filtered fluid, this property of said pores being preserved even after the fusing of the coatings.

In practice, the filtering element often comprises several superposed metallic gauzes or two assemblies of uniformly arranged crossed wires whose thickness is greater than the minimum thickness considered above (see Figure 4).

In the case of an assembly comprising several gauzes arranged parallel to one another, the constituent wires of any individual gauze are bonded by fusing, at certain at least of the points of contact, to the constituent wires of the neighbouring gauzes.

The assembly of wires are disposed within a peripheral wall 5 (see Figure 5), which may comprise for example an annular element capable of being incorporated within a pipe, the extremities of the wires of the assembly contacting and being fused to the wall 5.

In this construction, a connection is formed between each constituent wire of the assembly of wires 1 and the peripheral wall, so that no passages for unfiltered fluids are provided. The fluid to be filtered passes necessarily through the assembly of wires, for example through all the layers of wires when the element comprises superposed gauzes, without being able to bypass certain of these layers, as would be produced with less than complete bonding to the peripheral wall—as may occur for example if the stack of gauzes were clamped by a crimping operation at their extremities.

According to a preferred embodiment of this invention, illustrated by Figure 6, there are superposed and connected together several metallic gauzes T_1, T_2, T_3 with a pore diameter decreasing in the direction of the fluid to be filtered, shown by the arrow F.

With this construction, it is possible to modify and to orient the flow of fluid passing through the filter, so as to stop the particles in successive planes thereby slowing down clogging and prolong the useful life of the filtering element. To do this, it is convenient to assemble filtering elements whose pore diameters vary as a function of the desired filtration characteristics.

Moreover, for this construction, the pressure losses across the filter due to clogging develops more slowly than with conventional filters.

In the preferred embodiment shown in Figure 7, an assembly of gauzes T_4, T_5, T_6, T_7, T_8 of the type of that of Figure 6 is shown, this assembly being arranged inside a peripheral wall 5 having an opening 5*a*, through which it is possible to draw out laterally filtered liquid. In order that the filtering assembly may preserve its efficiency, it is advantageous to arrange the assembly of gauzes such that the opening 5*a* is situated down-stream of the finest gauze of the assembly thereof. Downstream of the finest gauzes and at the level of the opening reinforcing gauzes are preferably provided, these having thick wires, as shown by T_7 and T_8.

To arrange a filtering element of this invention inside a pipe, the arrangement shown in Figure 8 may be adopted. The filtering element, denoted as a whole by 9 in this Figure, is arranged against an internal step 10 within the pipe 8, between either an upstream annular seal or two annular seals 11 (as shown), and a threaded ring 12 screwed into the pipe. The ring 12 may not be necessary for some applications.

The assembly of crossed wires used in the filtering element can be formed into the required shape by machining using mechanical tools or by electrolytic corrosion techniques, the latter being selected, especially, to trim surfaces previously machined mechanically.

The fusing of the extremities of the wires to the peripheral wall is naturally effected by the application of heat thereto. This heating may be effected by high temperature gas heating (oxy-acetylene, plasma arc) or by electric resistance or arc welding. As mentioned above, the assembly of wires may be machined if necessary in order to ensure that it fits properly within the peripheral wall.

The metals from which the wires used for assembling in the filtering elements according to the invention may be selected from any metals or alloys which can be drawn into wires. In practice, these wires are of circular cross-section, simply for ease of manufacture, but wires of different cross-sections would also be suitable. The diameter of these

wires used is selected as a function of the required mesh pores and the required rigidity that a finished element is desired to display.

In the case of metallic gauzes and to obtain the smallest pore diameter possible, woven gauzes with wires having diameters of the order of 12 or 15μ can be used, this being the limiting lower diameter of wires which can be manufactured and woven at present at an acceptable cost. This permits the manufacture of gauzes having pore sizes of the order of 12μ, and this can be brought down, for example, to the value of 6μ by coating the assembly of wires with a metallic layer 2 of thickness e of 3μ. Pores of this size can still give acceptable pressure losses for many fluids to be filtered, and when finer wires become commercially available, it may not be necessary to coat the entire assembly to obtain such small pore sizes.

For the fusing operation, in the case of a gauze the thickness e of the metallic coating 2 is selected dependent upon:

the number of gauzes to be assembled (the thickness of the coating should be increased as the number of gauzes is increased);

the dimensions of the mesh (the thickness of the coating should be smaller for smaller mesh pores);

the material from which the wires are made; and

the coating material itself.

In this invention, the coating thickness must be from 1μ to 50μ.

Where the assembly of wires is not in the form of a gauze, but comprises simply crossed wires, the thickness e of the coating should be slightly less than that for a gauze.

Preferably, the thickness e of the coating is from 2 to 15μ. The quantity of metal present in the coating 2 must be sufficient to allow secure bonding of the wires by fusing at a sufficient number of their points of contact.

In order to assemble a filtering element within a peripheral wall element 5, there may be provided on the latter a layer of fusible metal, of thickness generally in the neighbourhood of 10μ and at least 1μ.

It may be advisable to protect the filtering element once assembled by a further coating to give the element a corrosion resistance. This further coating may then be applied in a similar manner to the coating 2.

To coat the wires with the metallic coating 2 and/or the peripheral wall with a fusible metal layer, and especially wire gauzes, the following methods may be mentioned:

an electrolytic method;

an auto-catalytic chemical reduction method; and

a thermochemical decomposition method.

There may also be used:

thermal evaporation under vacuum or cathodic spraying; and

coating and stoving of a finely divided metal in a colloidal suspension in an essential oil.

The selection of the particular method of applying the fusible metal depends on the wire material and especially on the metal to be coated.

There will be described below in more detail the more important of these methods by illustrating them by numerical examples.

1. Coppering of stainless steel gauzes electrolytically.

The gauzes are previously cut out to the desired size and placed in an electrolysis apparatus intended to hold the gauze in a vertical plane and to ensure good distribution of electric current during electrodeposition.

The gauze positioned on the apparatus is then subjected to the following sequence of treatments:

degreasing by a solvent in the vapour phase,

electrolytic degreasing,

rinsing in tap water,

cleaning in a 10% hydrochloric acid solution at 20°C for 2 to 5 minutes according to the state of oxidation of the gauze,

rinsing-neutralization (solution of 1 g/l soda),

coppering effected in a solution comprising:

Cu and Na double cyanide	30 to 50 g/l
Na carbonate	10 to 20 g/l
K and Na double tartrate	30 to 40 g/l

The temperature of the bath is 50°C and the density of the current 2 A/dm² of real surface.

The gauze is immersed in the bath under current.

The duration of the operation is from 5 to 15 minutes.

At the end of the coppering operation, the gauze is subjected to a final rinsing in tap water.

The thickness of the layer of copper thus obtained is from 3 to 12μ.

2. Autocatalytic chemical nickeling.

This nickeling can be applied to gauzes of stainless steel such as those referred to as X3 CN 18—10 types.

In this case, the gauzes can be treated without any special apparatus; they are simply suspended from a stainles steel wire, for example.

They are subjected to the following range of treatments:

degreasing by solvent in the vapor phase,

chemical degreasing,

rinsing in tap water,

activation in a 50% hydrochloric acid solu-

tion at 20°C (ambient temperature) for 1 minute.

rinsing in deionised water agitated by an ultra-sonic stirrer,

chemical nickeling in a solution comprising:

nickel chloride	30 g/l
sodium hypophosphite	10 g/l
ammonium chloride	50 g/l
ammonium citrate	100 g/l

pH 8 to 10 adjusted with ammonia.

The temperature of the bath is 90°C and the duration of the operation is about 100 minutes (for a deposition of 10 microns).

Note: The gauze must be immersed under a voltage of the order of 1V in order to 'initiate' the reduction reaction on the stainless steel. This voltage is eliminated as soon as the reaction has started (after some ten seconds).

3. Pyrolytic deposition of nickel.

This deposition is effected on refractory steel gauzes by employing the pyrolysis of an organometallic compound of nickel. The most currently used compound is nickel carbonyl which is normally decomposed at temperatures between 130 and 220°C. To do this, the pure carbonyl, or diluted with carbon dioxide or carbon monoxide, is introduced into the reaction vessel wherein is situated the part to be coated. The working pressures can be fixed between 0.1 torr and atmospheric pressure. The addition of a sulphur-containing gas, and in particular sulphuretted hydrogen, to the gaseous mixture, enables nickel to be deposited at lower temperatures, of the order of 60 to 100°C. The metallic gauzes to be coated are heated to the desired temperature for the deposition by high frequency induction, by infrared radiation, by the Joule effect, or by any other means capable of keeping the temperature as uniform as possible, within a gaseous atmosphere.

Before introduction into the reaction chamber, the gauzes are simply degreased by solvent in the vapour phase.

To obtain a thickness of nickel of 10μ, recourse is had to the following conditions: partial pressure of the nickel carbonyl: 10 to 20 torr; temperature of the substrate: 200°C; duration of treatment: about 10 minutes.

It is also possible to make the assembly of wires for use in the filtering elements according to the invention from wires precoated with the metallic coating. In other words, the coating 2 can be applied to the wires 1 for example at the outlet to the wire-drawing die. To do this, the device and the method described in British Patent Application No. 27 136 filed 9th June 1972 by the Agencie Nationale de Valorisation de la Recherche (ANVAR) under the title: "Method and device for electrolytic deposition" may be employed.

To unite the gauzes, the constituent wires of which carry a metallic coating 2, to one another or with assemblies of ordered wires 1, also provided with the coatings 2, and in the latter case to connect together the constituent wires of these assemblies, these gauzes (and/or the assemblies of ordered wires) are stacked on a plate and they are urged together by sufficient applied pressure such that the number of points of contact will, when fused, hold the whole structure together. In practice, pressures of the order of 10 to 50 g/cm² may be used. The operation of fusing proper then follows, by bringing the assemblies thus prepared in neutral or reducing atmosphere, to a sufficient temperature to cause the melting and fusing of the metal constituting the coatings 2.

In practice, this temperature is selected to be about 50°C above the theoretical melting point of the metal of the coatings 2 and it is maintained for a duration which is a function particularly of the mass to be heated. In general, this duration is of the order of at least 10 minutes.

To connect together simultaneously the gauzes of a stack of gauzes, and this stack to a peripheral wall, for example in the form of a ring, the procedure may be as follows:

The gauzes are cut out for example by stamping to a diameter slightly more than the bore of the ring, before of after the constituent wires have been provided with the coating 2.

The diameter of the gauzes should be of the order of 1/10 mm more than the bore of the ring. However, this dimension varies slightly with the diameter of the filter, so that the interference thus caused does not spoil the flatness of the gauzes after fusing of the coatings.

The ring is coated initially with a layer, of a thickness in the neighbourhood of 10μ and at least equal to 1μ, of the same metal as the coating 2. It is also possible, to not coat the ring with a layer of the coating metal and still obtain satisfactory results. For this latter case it is solely the metal of the wire coatings which serves to bond the wires to the ring.

The gauzes are introduced inside the ring and the assembly is brought to the fusing temperature for a duration of the order of 10 minutes.

Below, there are described several examples of filtering elements illustrating the embodiments of Figures 4 to 9.

EXAMPLE:

a) Element constituted by a stack of 11 gauzes of 51 mm diameter positioned in the following order:

mesh opeings (in microns: 630, 450, 160, 90, 56, 90, 160, 200, 280, 450, 450;

diameters of the wires (in mm): 0.32, 0.24,

0.11, 0.05, 0.04, 0.05, 0.11, 0.14, 0.18, 0.24, 0.24 assembled inside a ring of inner diameter 51 ± 0.10 mm and of outer diameter 52.9 mm, of height 4 mm, for direct filtration before the dies, of a polymer under pressure (Figure 8).

b) Element constituted by a stack of three gauzes:

mesh openings (in microns): 630, 160, 33,

diameters of the wires (in mm): 0.32, 0.11, 0.07/0.04 assembled together and cut out in an oval shape of about 80×40 mm after assembly, this element being used to hold sand which is used as a filter situated before the dies of a polymer under pressure.

It will be appreciated that filtering elements of this invention display at least some of the following advantages and characteristics (depending on the particular embodiment):

Increased stability of the meshes after positioning of the fusible metal coating;

increased mechanical strength of the assemblies;

load losses (i.e. pressure head losses) less than those of conventional materials for the same use;

the elements to be employed to hold sand used in the filtration of fluids which may or may not be pasty (polymers);

the sizes and distribution of pores (openings) is predetermined in the thickness of the material;

clogging is slowed down due to the arrest of particles in different planes of the material, giving increased life.

complete fluid-tightness between the filtering element and a pipe in which it is mounted by being squeezed between one or two seals at its ends;

complete seals along the inner surface of of the peripheral wall against the wires;

protection against corrosion by a suitable selection of the coating; and

filtration safety.

WHAT WE CLAIM IS: —

1. A filtering element comprising a peripheral metallic support surrounding an assembly of uniformly arranged crossed metallic wires, with the wires contacting the support at their extremities, at least some of the wires having a uniform metallic coating of silver, copper, gold or nickel, or of an alloy having as a major constituent one of these metals, the coating being from 1μ to 50μ thick, the said coated wires being bonded both to one another and, where they contact the peripheral support, to the support by means of the metallic coating being fused to the points of contact respectively of the crossing wires and of the wires with the support.

2. A filtering element according to claim 1, wherein the wires are woven together to form the assembly thereof.

3. A filtering element according to claim 1 or claim 2, wherein the peripheral metallic support has a layer of fusible metal of a thickness of from 1 to 10μ, for bonding with the metallic coating on the wires, the fusible metal layer being of silver, copper, gold or nickel or of an alloy having as a major constituent one of these metals.

4. A filtering element according to any of the preceding claims, wherein the thickness of the coating on at least some of the wires of the assembly is of from 2 to 15μ.

5. A filtering element substantially as hereinbefore described with reference to the Examples and/or the accompanying drawings.

6. A method of manufacturing a filtering element according to any of the preceding claims, wherein an assembly of crossing wires at least some of which are provided with a uniform metallic coating of silver, copper, gold or nickel or of an alloy having as a major constituent one of these metals is arranged within a peripheral metallic support such that at least some of the wires contact the support at their extremities, and then the assembly and support are heated such that the metallic coatings on at least some of the wires fuse to join the wires together at their points of contact, and to join the wires to the support.

7. A method of manufacturing a filtering element substantially as hereinbefore described with reference to the Examples and/or the accompanying drawing.

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Fig.1.

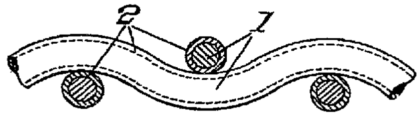

Fig.2.

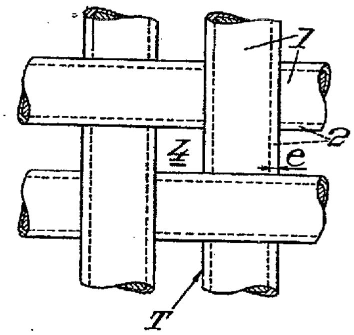

Fig.3.

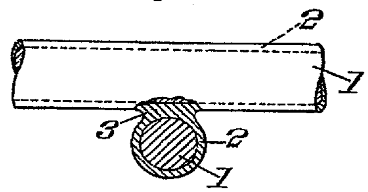

Fig.4.

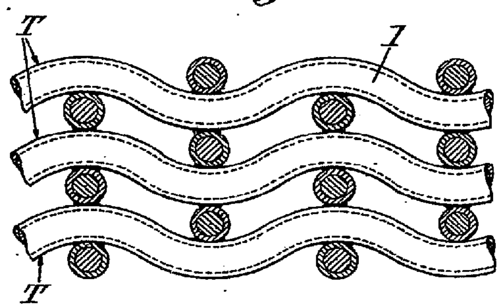

Fig. 5.

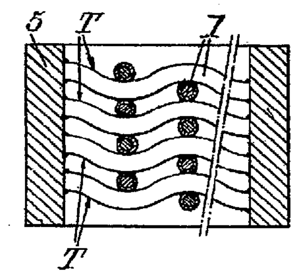

Fig. 6.

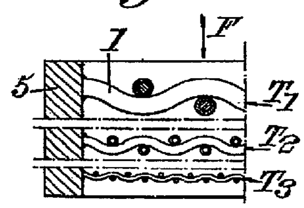

Fig. 8.

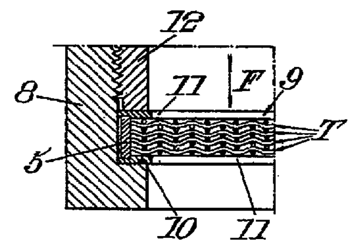

Fig. 7.